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BIOLOGICAL SURVEY

PERRY RESERVOIR

KANSAS

AUGUST 1969

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Federal Water Quality Administration
United States Department of the Interior
Cincinnati, Ohio

1970

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The report describes a survey of Perry Reservoir, Kansas, and adjacent sections of its main tributary, the Delaware River, which was conducted in August 1969. The objectives were to determine existing biological conditions and water quality in the reservoir and to determine the effects of the impoundment on the biota and water quality of the Delaware River.

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INTRODUCTION

As requested by the U. S. Army Corps of Engineers, through the Missouri Basin Region of the Federal Water Quality Administration, a survey of Perry Reservoir, Kansas, and adjacent sections of its main tributary, the Delaware River, was conducted in August 1969. The objectives were to determine existing biological conditions and water quality in the reservoir and to determine the effects of the impoundment on the biota and water quality of the Delaware River. Pre-impoundment conditions were documented in studies conducted during 1967[1,2].

The survey was conducted by biologists from the National Field Investigations Center, Cincinnati, Ohio, with assistance from the State of Kansas and the Army Corps of Engineers. Plankton, benthos, and nutrient-chemistry samples were collected and analyzed by personnel from the National Field Investigations Center. Additional physical and chemical samples were collected and analyzed by personnel from the Kansas State Department of Health.

A rolled earthfill dam, three miles northwest of Perry, Kansas, impounds the waters of the Delaware River, a tributary

of the Kansas River, to form Perry Reservoir. The reservoir, located in Jefferson County, Kansas (Figure 1), has a conservation pool capacity of 290,000 acre-feet, a surface area of 12,000 acres and 160 miles of shoreline. At flood pool level, Perry Reservoir has a capacity of 770,000 acre-feet. In 1967, the reservoir was flooded and drained prior to final filling in 1968. The impoundment inundated soils considered to be among the most productive in the state. The multipurpose reservoir, operated primarily for flood control and low flow augmentation, controls a 1120 square mile drainage area in the more humid section of the state. At the request of the State of Kansas, a portion of the impoundment was allocated for future water supply. Because of its proximity to several large cities, the reservoir also serves as a recreational area.

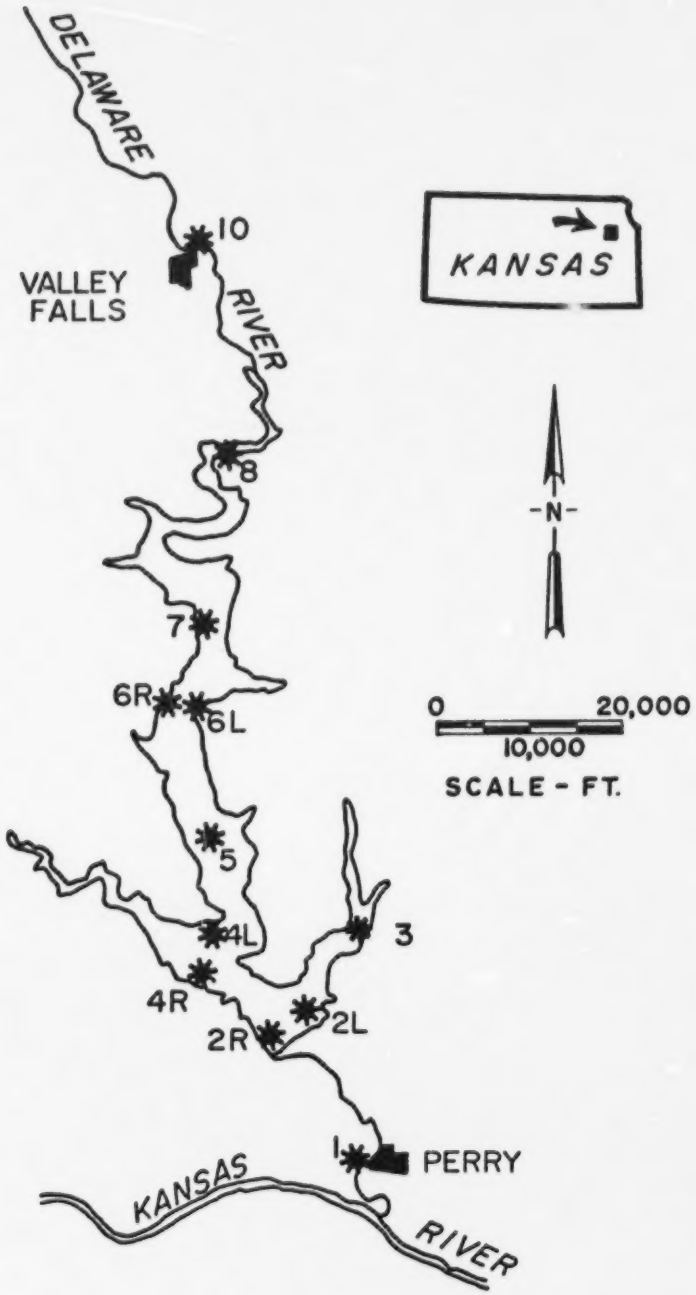

FIGURE 1. BIOLOGICAL SAMPLING STATIONS, PERRY RESERVOIR, KANSAS. AUGUST, 1969.

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PRE-IMPOUNDMENT STUDIES

Pre-impoundment biological surveys were conducted by personnel from the Missouri Basin Region, Federal Water Quality Administration, in March and October, 1967, on the Delaware River between Perry and Valley Falls[1,2]. These surveys revealed that biological conditions in the river were very similar throughout the study area. The associations of benthic organisms were those characteristically found in clean waters although the diversity of the benthic fauna decreased gradually in the more downstream reaches. Siltation of the river bottom, resulting from reservoir construction activities, had a detrimental effect on the biotic communities in several areas. Phytoplankton populations were considered indicative of good water quality, although phytoplankton populations in March were large (6,000-15,000 cells/ml). Few undesirable kinds of plankton were present.

POST-IMPOUNDMENT STUDY

During the August, 1969, survey, thermal stratification did not exist; temperatures in the reservoir were uniform in the upper waters and varied only 1° C in the lower depths (Table 3). This vertical uniformity of temperature was caused by mixing of the water by wind action. Winds of 15-20 mph were common during the survey.

The dissolved oxygen content of the upper waters (0-10 ft.) ranged from a minimum of 5.5 mg/l at station 2 to a maximum of 8.1 mg/l at station 4 (Table 3). Some chemo-stratification existed in the downstream end of the reservoir (stations 2 and 3), as the dissolved oxygen decreased from 5.8 - 8.0 mg/l near the surface to only 0.8 - 1.0 mg/l near the bottom. Thorough mixing of the waters of the impoundment did not occur in the lower depths. Oxygen depletion near the bottom of the reservoir may be attributed to the decomposition of recently inundated organic materials. This is a common phenomenon in recently formed reservoirs which cover vegetated land and will probably last until most of the organic materials are decomposed or are covered by inorganic silt. This process may take several years.

PHYTOPLANKTON

At station 8 the number of phytoplankton (suspended algae) decreased 50 percent as compared to upstream plankton populations (station 10). Because of the reduction in current velocity in this backwater area, particles of inorganic materials adhering to the planktonic organisms settled to the bottom and pulled the plankton with them.

Mixing of the water by wind action effected a uniform vertical distribution of planktonic organisms within the reservoir (Table 1). Phytoplankton were numerous in some reaches of the impoundment below the lowest levels of light penetration. The phytoplankton were able to survive at the non-lighted depths because they were periodically carried by the mixing waters into the lighted zone where they could photosynthesize food materials. The number and volume of phytoplankton were greatest in the upstream reaches of the reservoir and decreased downstream (Table 1). At station 7, 7,600 cells/ml (6.0 parts per million wet volume) were present but there were only 2,300 cells/ml (1.3 ppm wet volume) at station 2.

The inflowing waters of the Delaware River were rich in the algal nutrient, phosphorus, and contained 0.19 mg/l

total phosphorus and 0.04 mg/l soluble phosphorus (station 10). Nitrogen, another important algal nutrient, was not overly abundant in the river (1.05 mg/l total nitrogen of which 0.25 mg/l was inorganic nitrogen). The largest standing crops of plankton were present in the upstream reaches of the reservoir because of the influx of phosphorus. Phosphorus probably was the limiting nutrient in Perry Reservoir. Phytoplankton standing crops decreased in the more downstream reaches of the reservoir as did the availability of phosphorus (Figure 2); nitrogen was more abundant in the downstream reaches than in the upstream reaches (Table 1).

In the Delaware River downstream from the dam (station 1), the plankton standing crop was similar to that in the reservoir near the dam. The river plankton community was also similar in composition to that in the reservoir although there was a reduction in variety. The large concentrations of total phosphorus and total nitrogen in this reach of the river resulted from the discharging of water from the lower depths of the reservoir where nutrient concentrations were greatest.

The depth of the euphotic zone (1 percent level of light penetration) in Perry Reservoir was probably a function of plankton density in the euphotic zone (Figure 3). At

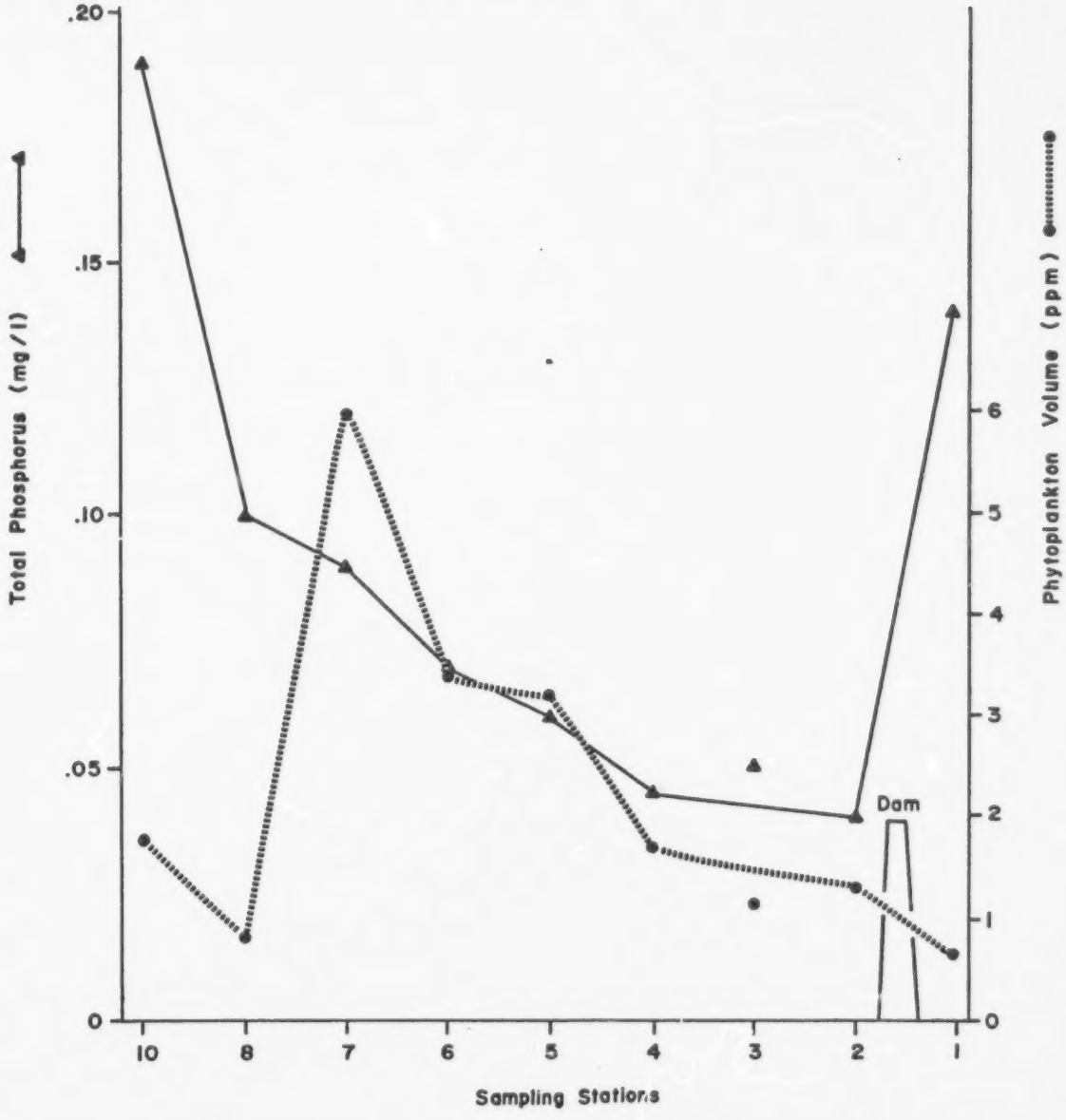

FIGURE 2. TOTAL PHOSPHORUS AND PHYTOPLANTON VOLUME, PERRY RESERVOIR, KANSAS, AUGUST, 1969.

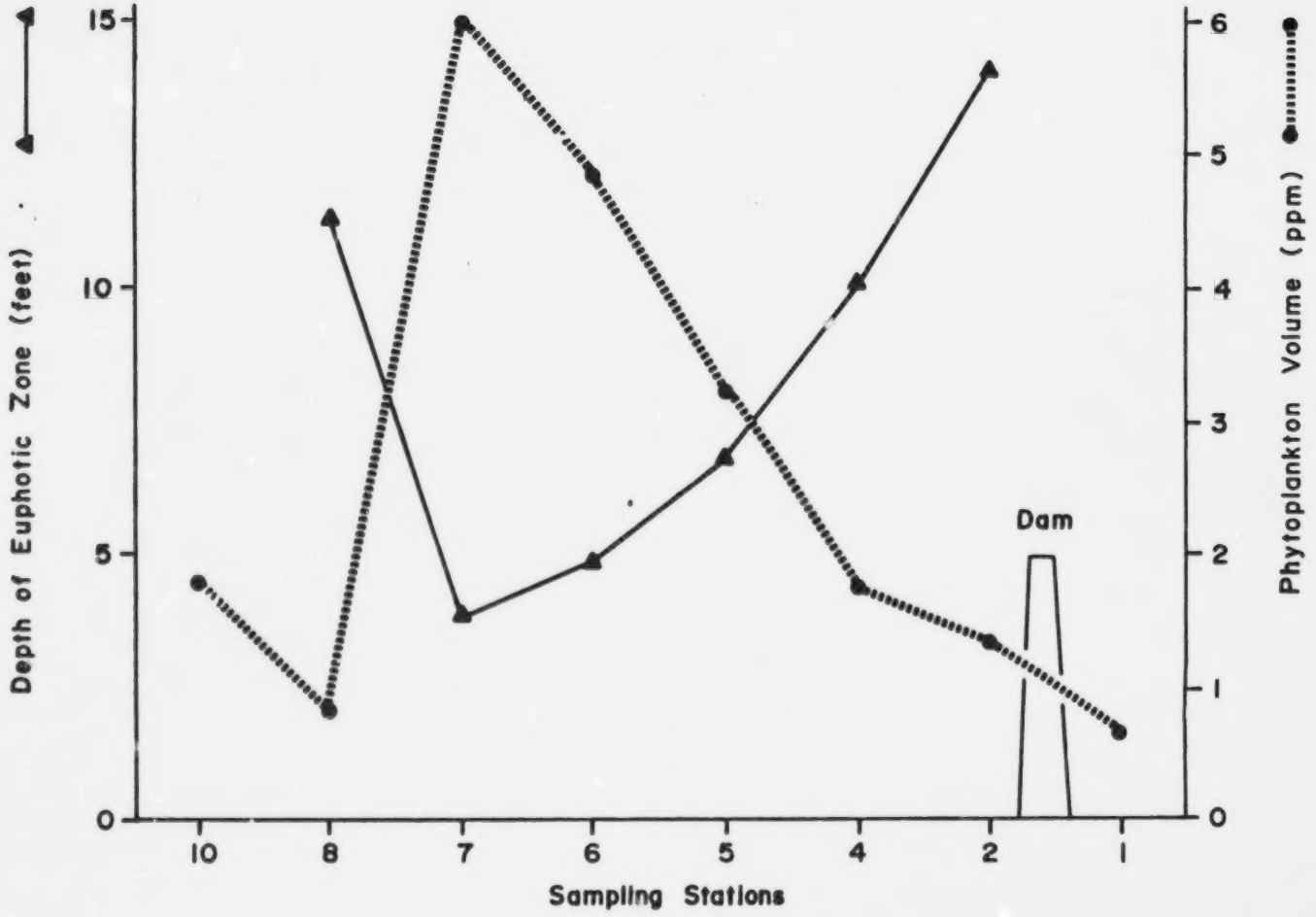

FIGURE 3. DEPTH OF EUPHOTIC ZONE AND PHYTOPLANKTON VOLUME IN EUPHOTIC ZONE PERRY RESERVOIR, KANSAS, AUGUST, 1969.

station 7 where the phytoplankton standing crop was greatest (6 ppm wet volume), the euphotic zone was shallowest (4 ft.). Near the dam, where the plankton volume was only 1.4 ppm, the euphotic zone extended to a depth of 14 ft. In the downstream reaches, as the plankton density decreased and less light was screened out by the plankton, the depth to which light penetrated increased. Concentrations of dissolved solids (indirectly determined by conductivity measurements) and total solids were rather constant between stations 2 and 7 (Table 3), and do not account for the changes in the depth of light penetration.

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BOTTOM ANIMALS

Upstream from the reservoir (station 11), the benthic community contained organisms associated with clean-water environments and was very productive. This riffle area near Valley Falls had a benthic standing crop of 1,300 organisms/sq. ft. Bottom organisms were 16 times more abundant in this reach in 1969 than they were during pre-impoundment studies two years earlier. Of the 14 different kinds of organisms collected, two kinds of algal-feeding caddisfly larvae comprised 70 percent of the benthic community.

A reduction in river current and subsequent silt deposition resulted in a sparse and undiversified benthic community at station 8. Because of the lack of desirable bottom habitat, only a small population of phantom midge larvae had become established there.

The impounding of the Delaware River has eliminated most of the bottom fauna that were present in that part of the river now inundated by Perry Reservoir. Flowing-water organisms have been replaced by lentic or standing-water forms. After one year of impoundment, the bottom community in the reservoir was not diverse as only four kinds of

benthic animals were found at stations 2 through 7. Phantom midge larvae were predominant and constituted 95 percent of the organisms collected. These midge larvae are common inhabitants of large lakes and reservoirs and are desirable fish-food organisms. Benthic productivity in all reaches of Perry Reservoir was considerably higher than other reservoirs in this part of Kansas[3,4,5]. The standing crop of benthos ranged from 100 to 500 organisms/sq. ft. and averaged 280 organisms/sq. ft. (Table 2). Because of the abundance of food materials (algae and inundated vegetation), high benthic productivity is a common occurrence in recently formed reservoirs. This high production of benthic organisms lasts until algal productivity decreases and inundated vegetation is utilized or decomposed (generally two to five years). The large populations of phantom midge larvae present in Perry Reservoir during this period should result in high production rates of fish.

As other kinds of benthic organisms invade the reservoir and successfully become established, the diversity of the benthic community can be expected to increase. The phantom midge larvae will probably remain the predominant form but other kinds of midge larvae and aquatic worms will become more prevalent.

Downstream from Perry Dam (station 1), only six different kinds of bottom animals were collected. The total benthic population numbered only two organisms/sq. ft. This is a significant reduction in the standing crop of benthic organisms since the 1967 pre-impoundment studies when 52 organisms/sq. ft. were present. The paucity of bottom animals in this reach of the river was probably the result of siltation and the accompanying loss of bottom habitat. Much of the substrate at this sampling station was silt covered leaving little desirable bottom habitat for aquatic organisms. The siltation in this reach of the Delaware River was probably a result of filling and draining the reservoir in 1967. Silt from the exposed reservoir bed, which had been cleared of trees and brush, settled in the river channel. Since that time reservoir discharges have not been sufficient to scour the river bottom downstream from the dam. Clinging mayflies were moderately abundant on the undersides of the few rocks in this area and burrowing mayflies also were present. The presence of these pollution-sensitive organisms indicates that water quality was good in the river downstream from the dam, but bottom conditions were so poor that a diversified benthic community could not become established.

Smartweed beds have developed in the mid-reaches of the reservoir. They were not extensive and should decrease in size in several years. At present the beds provide desirable habitats for fish and are not considered to be a nuisance for such activities as boating or water skiing.

SUMMARY

The impounding of the Delaware River has created a reservoir that is very productive at all biological levels yet is not over-productive to the extent that organisms are so abundant they create nuisances. The large standing crop of benthic organisms in all reaches of Perry Reservoir is probably the most prominent feature of the biological community. Most of the benthic community was made up of desirable fish-food organisms. This abundance of fish-food organisms can be expected to be present for several more years and should enhance the production of sport fishes that will support a desirable recreational use of the reservoir.

Although the impoundment does not effect a decrease in water quality downstream from the dam, it has produced a detrimental effect on the river biota. A silted river bottom has resulted from reservoir construction activities. Because of this, the number of bottom organisms was very small. Fish-food organisms were scarce and could support only a limited standing crop of fish.

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Table 1. Phytoplankton and Nutrient--Chemistry Data

Perry Reservoir, Kansas - August 1969

Station No. →	10	8	7	6L	6R	5	4L	4R	3	2L	2R	1
Plankton Numbers -- cells per ml.												
Depth (ft.)												
Surf.	4256	2204	6670	8042	3940	5336	2830	4012	2646	2464	2006	2552
5			7616	6284	6160	5714	3132	3400		2232	2240	
10			8736	6026	5600	5202	2650	3024		1568	1232	
20			8356				2842	2622		2970	2346	
25			6702			1456						
30				3538			2726			2100	2754	
40											378	
Average (all depths)	4256	2204	7656	5967	5133	4066	2834	3147	2646	2420	2113	2552
Wet Plankton Volume -- parts per million (ppm)												
Depth (ft.)												
Surf.	1.78	.83	6.23	4.39	2.68	3.48	1.21	1.93	1.16	1.36	1.42	.65
5			5.72	5.26	3.23	2.94	1.92	1.44		1.56	1.40	
10			7.23	2.93	3.23	3.07	1.55	1.82		1.02	1.31	
20			5.67			2.02	1.79			1.78	1.10	
25			5.76			.02						
30				2.28			1.63			1.40	1.57	
40											1.01	
Average (all depths)	1.78	.83	5.97	3.71	3.05	3.21	1.62	1.75	1.16	1.31	1.37	.65
Nutrient-Chemical Data - milligrams per liter (average concentration in water column)												
Total N	1.05	.88	1.16	1.22	1.32	1.38	1.39	1.29	1.49	1.37	1.31	1.7
Org. N	.8	.7	1.0	.8	.8	.7	.7	.6	.9	.7	.7	1.2
NO_3-N	.2	< .1	< .1	.3	.4	.6	.6	.6	.5	.5	.5	< .1
NH_3N	.05	.18	.16	.12	.12	.08	.09	.09	.19	.17	.11	.5
Total P	.19	.10	.09	.07	.07	.06	.04	.05	.05	.04	.04	.14
Sol. P	.04	.01	.01	.02	.01	.02	.01	.01	.02	.01	.01	.02

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Table 2. Bottom Fauna Data

Perry Reservoir, Kansas - August 1969

Station No. →	10	8	7	6L	6R	5	4L	4R	3	2L	2R	1
Mayflies												
Stenonema	35	-	-	-	-	-	-	-	-	-	-	*
Trichorythodes	*	-	-	-	-	-	-	-	-	-	-	-
Isonychia	10	-	-	-	-	-	-	-	-	-	-	-
Baetis	110	-	-	-	-	-	-	-	-	-	-	-
Hexagenia	-	-	-	-	-	-	-	-	-	-	-	*
Caddisflies												
Psychomyia	-	-	-	-	-	-	-	-	-	-	-	*
Cheumatopsyche	727	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche	450	-	-	-	-	-	-	-	-	-	-	-
Damselflies												
Argia	-	-	-	-	-	-	-	-	-	-	-	*
Hetaerina	*	-	-	-	-	-	-	-	-	-	-	-
Midges												
Chironomus	*	-	-	-	-	-	-	-	-	-	-	-
Polypedilum	323	-	-	-	-	-	-	-	-	-	-	2
Pelopia	-	-	3	-	-	-	-	-	-	-	2	-
Pentaneura	1	-	-	-	-	-	-	-	-	-	-	-
Biting Midges												
Bezzia	1	-	-	-	-	-	-	-	-	-	-	-
Phantom Midges												
Chaoborus	-	26	278	200	198	299	154	525	134	437	101	-
Bloodworms												
Chironomus	-	-	19	4	9	-	-	-	3	-	-	-
Hellgrammites												
Corydalus	*	-	-	-	-	-	-	-	-	-	-	-
Beetles												
Stenelmis	3	-	-	-	-	-	-	-	-	-	-	-
Amphipoda												
Hyalella	2	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	-	-	2	-	-	-	2	11	-	73	-	-
Clams	-	-	-	-	-	-	-	-	-	-	-	*
Total Numbers	1662	26	300	204	207	299	156	536	137	510	103	2
No. of Kinds	14	1	4	2	2	1	2	2	2	2	2	6

*Collected in qualitative samples only.

Table 3. Chemical and Physical Data

Perry Reservoir, Kansas - August 1969

Station	Depth (ft)	Temperature (°C)	Dissolved Oxygen (mg/l)	Total Solids at 180°C (mg/l)	Specific Conductance
1	Surf.	25.0	11.0	446	720
2	Surf.	25.5	5.8	216	340
	10	25.5	5.5	-	-
	20	25.5	4.0	-	-
	30	24.5	1.0	210	340
3	Surf.	27.0	8.0	214	340
	10	27.0	6.0	-	-
	18	26.0	0.8	-	-
4	Surf.	26.0	8.1	212	340
	10	26.0	6.5	-	-
	20	26.0	6.0	-	-
	25	26.0	5.5	208	340
5	Surf.	26.0	6.4	211	340
	10	26.0	6.1	-	-
	20	25.5	6.1	210	340
6	Surf.	27.0	7.9	216	350
	10	27.0	7.1	-	-
	15	26.0	3.6	-	-
7	Surf.	26.5	7.0	250	400
	10	26.0	6.2	-	-
	20	26.0	4.1	-	-
8	Surf.	29.0	9.1	340	560
9	Surf.	27.5	8.0	440	700
10	Surf.	27.5	9.8	-	-